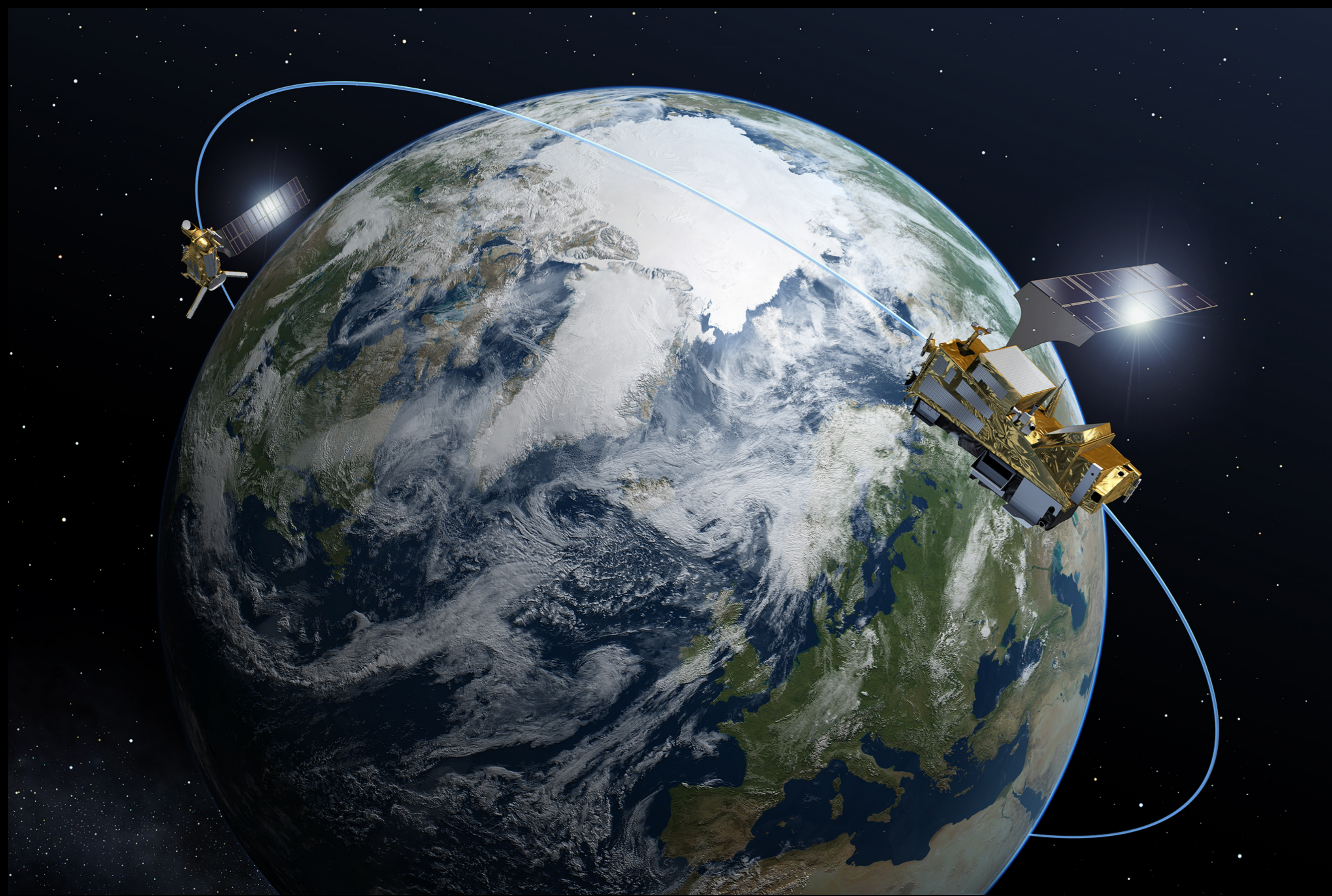


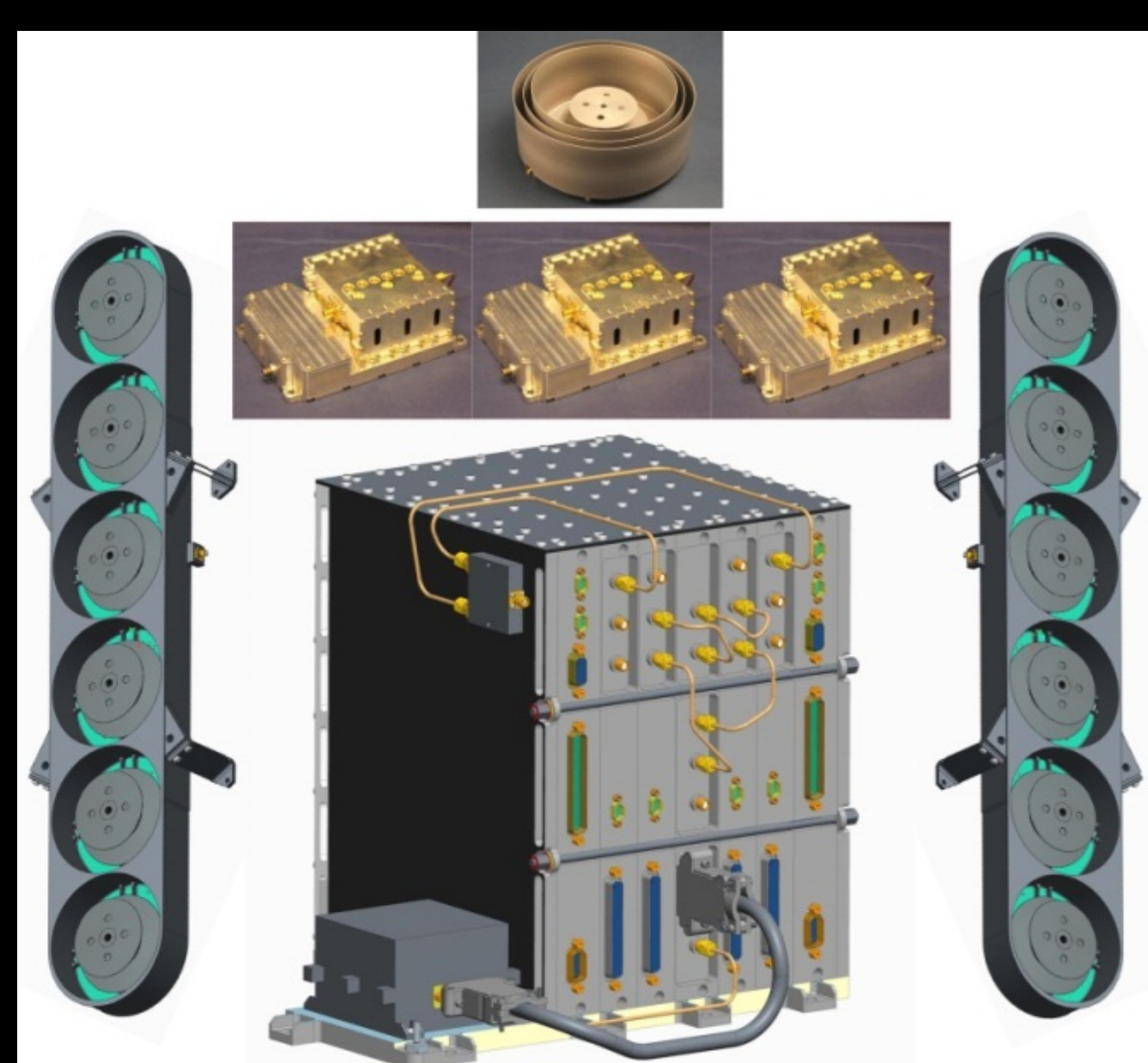
→ Preparation of a Science Plan for the Radio Occultation Instrument

Michael Kern, Axel von Engel, Alberto Garcia Rodriguez, Stefan Remus, Josep Rosello, Salvatore D'Addio, Biagio Forte, André Hauschild, Sean Healy, Jose van den Ijssel, Gottfried Kirchengast, Kent Lauritsen, Mark Ringer, Stig Syndergaard
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→ The Radio Occultation Instrument on MetOp-SG Satellite A and B

The main objective of the GNSS Radio Occultation (RO) mission is to support Numerical Weather Prediction and climate monitoring by providing measurements of bending angle profiles in the troposphere and the stratosphere with a high vertical resolution and accuracy. From bending angles refractivity profiles can be retrieved. From these, atmospheric temperature and humidity profiles as well as information on surface pressure can be retrieved. A secondary application to be supported by the RO mission is the space weather monitoring by provision of information on the Total Electron Content and on the atmospheric electron density.



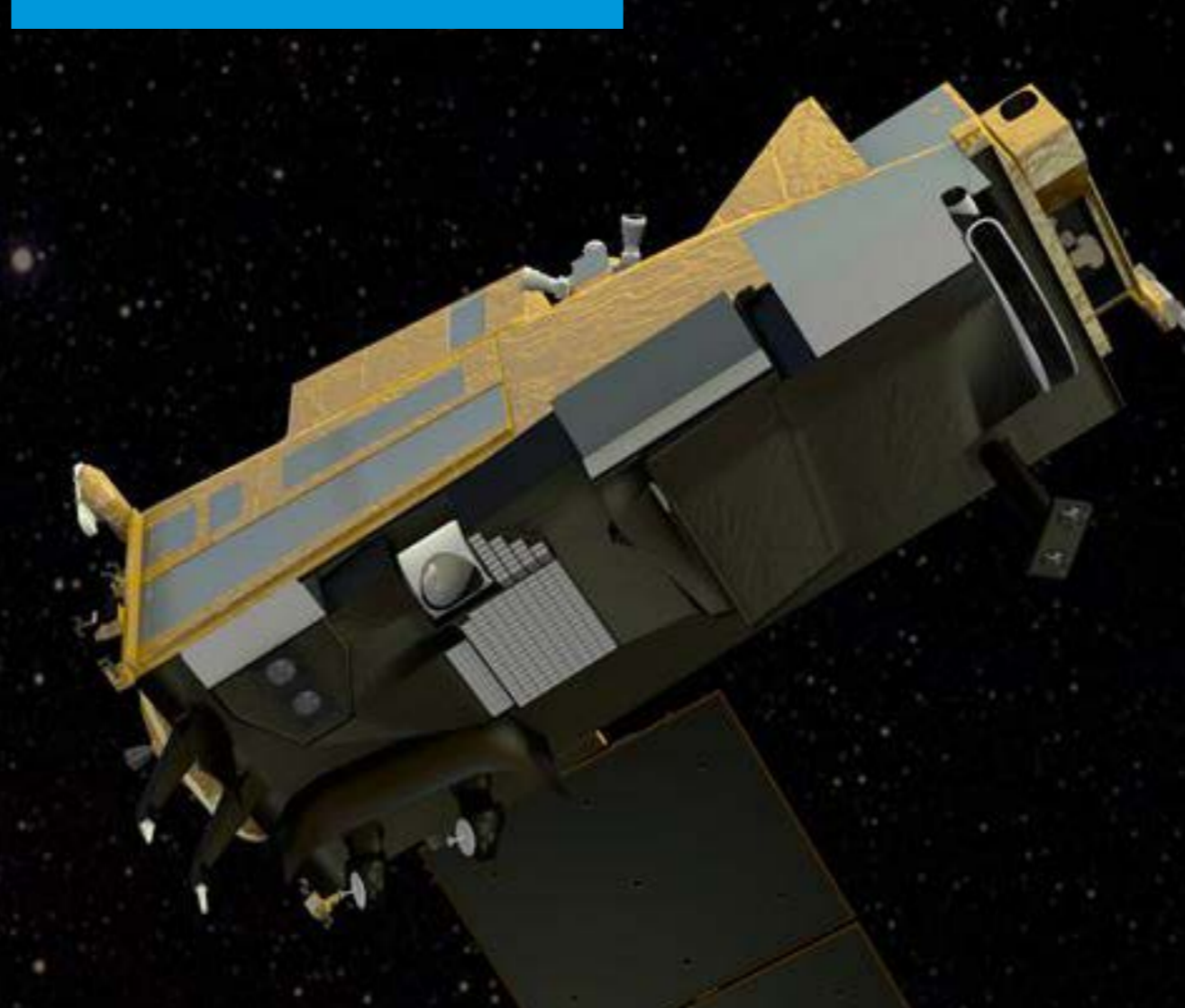
The RO-SG instrument (RUAG AB, Sweden)

The RO instrument will provide continuous operation during the EPS-SG mission life, for more than 21 years, and will be installed on both MetOp-SG satellites A and B. Innovative features of this new RO instrument are the possibility to observe, acquire and track signals from the modernized GPS constellation, from the Galileo, and potentially from the future, CDMA based, GLONASS and the Compass/Beidou navigation systems.

→ About EPS-SG/MetOp-SG

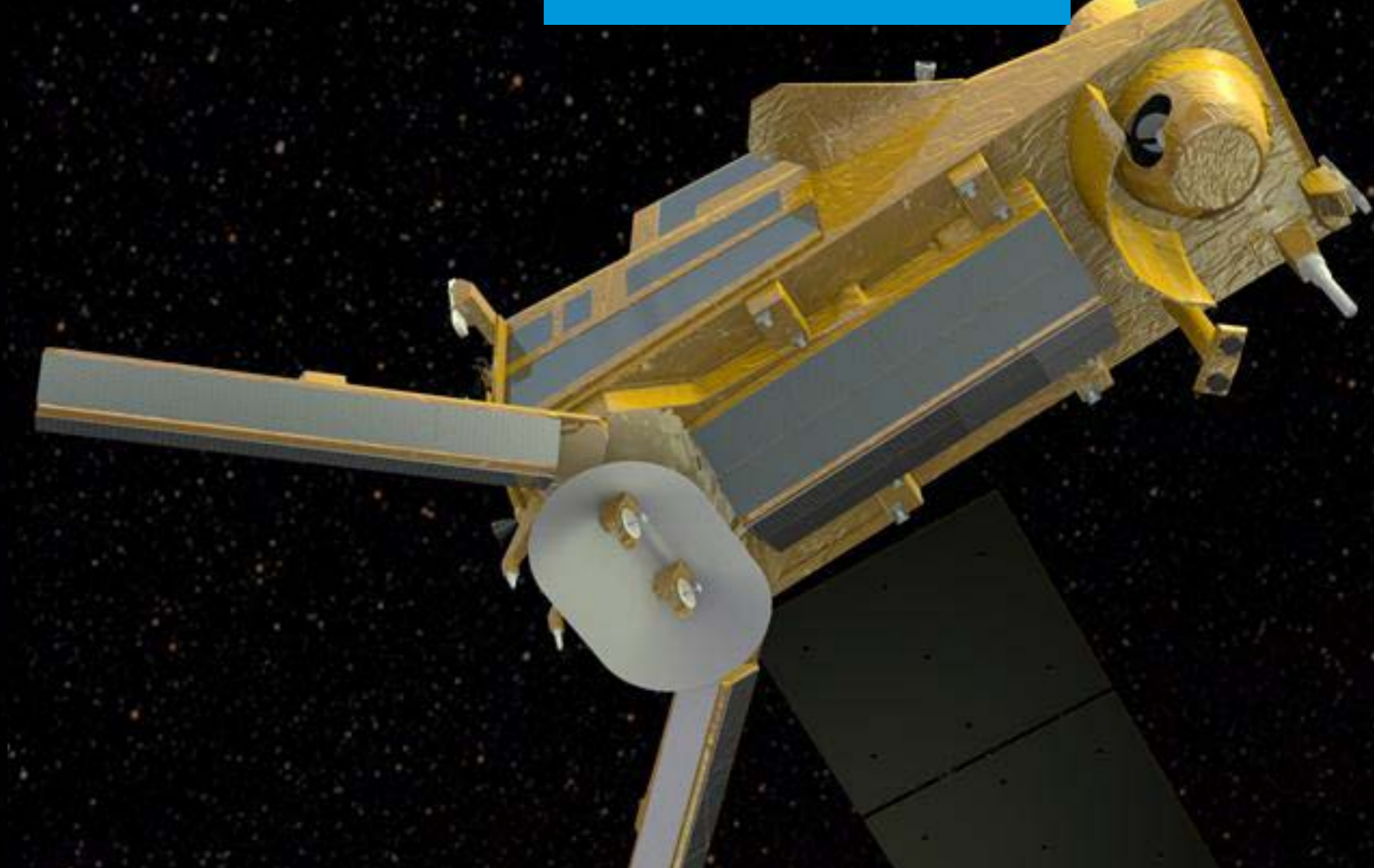
EUMETSAT Polar System (EPS) / Meteorological Operational Second Generation (MetOp-SG) is a collaborative programme between ESA and EUMETSAT. EPS-SG/ MetOp-SG is a follow-on system to the first generation series of MetOp satellites (MetOp-A and MetOp-B satellites were launched on 19 October 2006 and 17 September 2012; MetOp-C will launch in 2018), which currently provide operational meteorological observations from polar LEO orbit. The follow-on system is essential to avoid possible data gaps and to maintain Europe's role in such systems. ESA is responsible for the development of the prototype satellites and, on behalf of EUMETSAT, for the procurement of the recurrent satellites. EUMETSAT is responsible for overall end-users requirements, procurement of the launchers and LEO services, development of the ground segment, and also performs the operations of the satellites and ground segment.

Satellite A



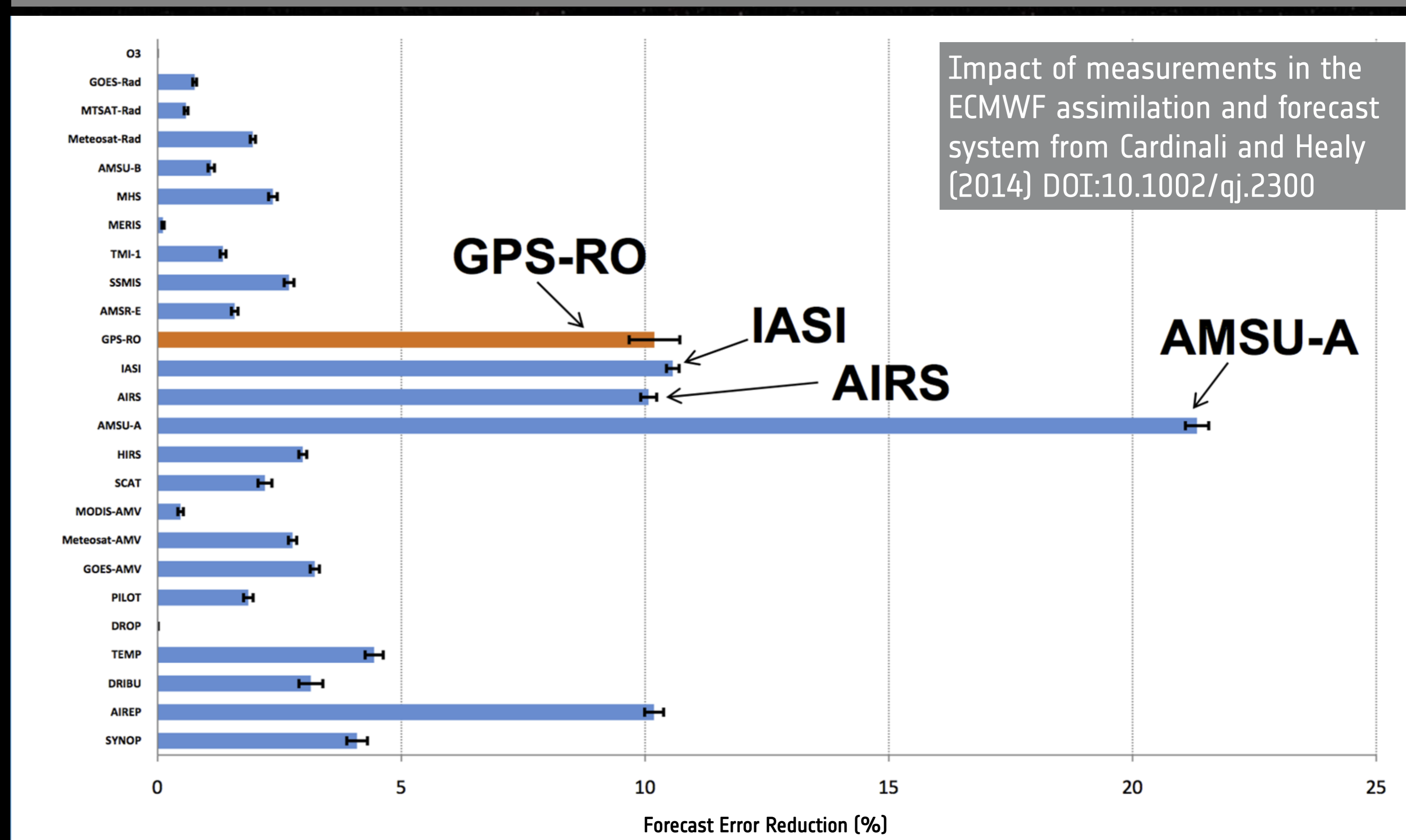
- Launch mass = 4.26 tons
- Mean power consumption = 3.6 kW
- Data rate = day / night / peak
68 / 26 / 85 Mbps

Satellite B



- Launch mass = 4.01 tons
- Mean power consumption = 2.6 kW
- Data rate = day / night / peak
16 / 16 / 18 Mbps

- Launcher: Soyuz in Kourou / Falcon 9 / Ariane 5
- Orbit: MetOp Sun Synchronous Orbit 832 km, 9h30 Local Time at Descending Node
- Controlled re-entry into the South Pacific Ocean Uninhabited Area



→ The RO Science Plan

The RO Science Plan (SP) details the scientific work needed to meet the RO mission objectives and provides a framework for required scientific research and development activities. It follows the EPS SP from the GRAS Science Advisory Group (SAG) and reviews on-going activities in the areas of:

- retrievals, software and databases
- gaps that might exist in the proposed product processing, product format, archiving, dissemination, reprocessing
- the level of compliance with the user needs

The SP provides advice on needs for additional studies & development:

- Written and compiled by the RO SAG, external experts and ESA/EUMETSAT
- Aimed at providing an independent advisory framework and a focus for the establishment of scientific research and development priorities

It is planned to compile the first complete and mature version of the SP by end of 2016.

Requirement	RO on MetOp-SG
Bending Angle Accuracy	0.5 μ rad @ 35km
Number of observations per satellite	~1100 occ/day (GPS+Galileo) ~2200 occ/day (as above +GLONASS, Compass)
GNSS constellations	Baseline: GPS, Galileo Potential: GLONASS, Compass
Closed Loop	Yes, @ L1 and L5, up to 250Hz
Open Loop for low altitudes tracking	Simultaneous Open Loop @ L1 and L5, Doppler Model and Range Model, 250Hz
Use of Pilot Signals	Yes, better performance for closed loop
Minimum Straight Line Tangent Altitude	-300 km
Maximum Straight Line Tangent Altitude	+80km atmosphere, 500km ionosphere

The RO instrument will provide more than 1100 occultation measurements per day with unprecedented accuracy, thanks to simultaneous tracking of Galileo and GPS satellites (baseline).

